

“KOLOSOK” RESOURCE CENTER AS A PART OF STEM- EDUCATION IN UKRAINE

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The article addresses the historical formation of informal STEM-competitions in Ukraine and highlights the components of “KOLOSOK”, complex innovative project. The current state of the International Interactive Natural Competition “KOLOSOK” has been analyzed; its main stages and the role of each in the development of natural-science knowledge, cognitive and research skills have been identified. The potential for social and cultural project “KOLOSOK” as to the implementation of educational reforms and development of STEM education in Ukraine has been determined.

Key words: STEM, competition, innovative project, giftedness.

Introduction

Educational reform is a global trend now that has also induced changes in the Ukrainian system of education. According to experts, in the near future, the most successful in the labor market will be the specialists able to think critically, set goals and achieve them, work in team, communicate in a multicultural environment and having others skills essential for the 21st century. Proposed new educational standards base on the “Recommendations of the European Parliament and the Council of Europe on key competencies for lifelong learning”, namely, mathematical competence, basic competences in the natural sciences and technology, digital competence, learning to learn throughout life, etc. [On Approval, 2018]. The formation of these competencies centers around the comprehensive development of intellectual and creative abilities based on the child’s natural curiosity with the use of research method of world cognition, and through engaging in work with media texts, reading and communication, active work in lessons and project activities.

School education in terms of competency-based approach should be focused on achievement of specific results: to teach to learn, explain world phenomena using science, understand their essence, causes, relationships, i.e. solve cognitive problems; to teach how to navigate the key problems of modern life, in the world of spiritual values; to teach to solve problems that are common to different types of professional activities (communication, search and analysis of information, organization

of joint activities, etc.); to solve problems of occupational choice, prepare for further education and life.

At the same time, the Law of Ukraine “On Education” declares a promising direction for the specialized education, in particular, science-oriented education, which provides research-based training, in-depth study of major subjects, acquisition of competencies required for further experimental, engineering and inventive activities [On education, 2017]. New educational trends require mechanisms to achieve the goals set by the reform. Important role among such mechanisms play modernization and enrichment of the educational content of the courses in natural sciences and mathematics. One of the latest topical slogans is STEM-education, or the movement aimed to expand the natural, mathematical and technical components of the formal and non-formal curricula. It has been launched in the United States and implemented in many countries around the world [Bybee, 2010: 996]. There is no common understanding of the concept of “STEM education” in the world practice [Scientific-methodical project]. According to US NSF recommendations, STEM includes subjects in mathematics, physics and astronomy, chemistry, earth sciences, life sciences, computer and information technologies, engineering, and even social sciences (economics, anthropology, psychology, sociology), as well as research in the field of STEM education [Sanders, 2009: 20-26].

For Ukraine, STEM-education is not something completely new. For over a century now there is operating a system of educational institutions for children and youth in the field of science and technologies and STEM-activities. One of them is a unique structure for gifted children – Junior Academy of Sciences of Ukraine (JASU). The educational space of Ukraine features a wide range of tools for the development of child’s STEM abilities: subject Olympiads and competitions for students; extracurricular education (technical, environmental-naturalistic and other STEM-oriented clubs, clubs for young technicians, children’s activity centers).

The development of a new Ukrainian school is a time consuming process, with a complete cycle ending in 2029. However, the school is forced to upgrade as quickly as possible, keeping up with the changes in society. The rate of changes is so high that it is impossible to achieve a quantum leap and to reach the desired result in short terms in the conditions of formal education only. Effective is the approach that involves integration of formal, non-formal and informal education with targeted use of educational resources provided by scientific institutions, museums, NGOs, manufacturing and business structures; the transfer of practical knowledge and unique experience of professionals to a wide range of students through professional support and various interactive forms of development children’s interest in nature, creativity, critical thinking, problem-solving skills, research skills, ability to express their thoughts through improvement of reading skills, etc.

Traditional and new pedagogical approaches to the formation of active learning environment include also those that have not been fully implemented yet but deserve the attention of teachers and administrative institutions in education. One of them is represented by a complex innovative project “KOLOSOK” that includes the

following: International Interactive Natural Competition “KOLOSOK”, popular science magazine for children “KOLOSOK”, and popular science newspaper for brainy children “KOLOSCHOK” [Bida, 2010]. The purpose of the article is to analyze the formation of this direction of STEM-education and its potential in Ukraine for implementation of educational reforms.

History of Non-Formal STEM-Competitions Establishment in Ukraine

In the early 80s of the 20th century, Peter Halloran, professor of mathematics from Sydney, organized a new competition game for Australian schoolchildren: tasks with options for answers that were checked by a computer. Thousands of students got the opportunity to take part in a game at the same time. This Australian national mathematics competition had an extraordinary success.

In 1991, French mathematicians organized this competition game in France naming it “Kangaroo” in honor of Australia. The first game brought together 120,000 college students. Soon the competition also covered schools and lyceums. In May 1994, mathematicians from Belarus, Hungary, Spain, the Netherlands, Poland, Russia and Romania decided to hold this competition in their countries that ensured the further development of this insightful mathematical event. In July 1994, the Parliamentary Assembly of the Council of Europe established the International Association “Kangaroo without Borders” in Strasbourg. Nowadays the association brings together participants from 65 countries, including Ukraine.

The first “Kangaroo” competition-game was held in Ukraine in 1997; the participants were from a few schools of Starosambirskiy District of Lviv Region, and Lviv Physics and Mathematics Lyceum of Ivan Franko Lviv National University. In 2018, 586,000 Ukrainian students took part in the two stages (national and international) of the “Kangaroo” competition.

The experience of mathematicians inspired physicists. Contacts with Belarusian colleagues, conducting at that time “Zoubryonok” competition game in physics, encouraged us to initiate a similar All-Ukrainian Physical Competition “Levenia”. The third Ukrainian competition, which unlike “Kangaroo” and “Levenia”, had no equivalents in the world at that time and became a completely Ukrainian “invention” was “KOLOSOK” competition established in 2003. At the beginning, it was a competition for 3-8th grade students. Nowadays, “KOLOSOK” has a status of an international competition [Order About Approval, 2011]. Participants include students of 1-11th grades. The first competition attracted 7531 students.

Belarusian Association “Competition” has introduced the unique multi-subject competition program. Belarusian schoolchildren take part in 16 subject contests, including “KOLOSOK”. [Public Association]. Cooperation with NGOs that conducted “KOLOSOK” contest in Russia terminated in 2014 due to Russian aggression against Ukraine.

Unlike the numerous intellectual competitions available in Ukraine, “KOLOSOK” is a complex socio-cultural project, its structural elements are

effective factors for the formation of educational environment with the aim of solving problems in the field of natural sciences [Bida, 2008: 303-307]. These include, firstly, International Interactive Natural Competition “KOLOSOK”, which goal is to increase children’s interest in cognition and to prepare teachers to lead activities that develop students’ cognitive abilities, engage students in research and personal studies and inventions, and also to stimulate educators to learn and explore their own capabilities. Secondly, All-Ukrainian popular science magazine for children “KOLOSOK”, all-Ukrainian popular science newspaper for brainy children “KOLOSOK” and a series of popular science publications for children and teachers “KOLOSOK Library”, aim to involve children into reading of non-fiction literature on natural subjects and to form teachers’ readiness for such forms of work that inspire to reading. Thirdly, team games “KOLOSOK Intellectual Show” and “KOLOSOK” summer natural school enable to implement active approach and effectively promote natural sciences. Fourthly, “KOLOSOK-online” is an Internet version of “KOLOSOK” competition, which encourages both, teachers and students, to self-improvement and work with various sources of information; it demonstrates how to reach the balance in the process of obtaining information between published and electronic sources of information, and appreciate technical innovations and books (Fig. 1)

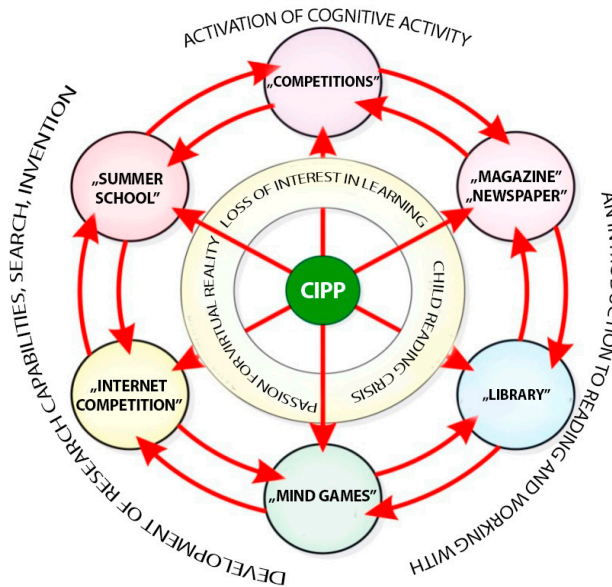


Fig. 1. Structure and tasks of the complex innovative pedagogical project (CIPP) “KOLOSOK”

Modern school needs educators with new professional qualities. The fifth component of “KOLOSOK” project – All-Ukrainian Internet Contest, “TEACHER OF THE YEAR”, was initiated in 2016, according to “KOLOSOK” magazine. The

contest is organized by the editorial board of the popular science magazine for children, “KOLOSOK”, and the organizing committee of the International Interactive Natural Competition “KOLOSOK” with the assistance of the Institute for the Modernization of Education of the Ministry of Education and Science of Ukraine, and the Institute of Gifted Child of the National Academy of Pedagogical Sciences of Ukraine. The aim of this competition is to support initiative and talented teachers in the field of natural sciences; identification of teachers mastering their subjects and wishing to improve their methods of shaping the students’ holistic view of the world, their ideas about the scientific pattern of the world, that are developing students’ motivation for studying natural science, forming stable skills to work with popular science literature, and developing reading competence, research and creativity. The need for teacher’s innovative activities was driven by the modernization of the education system and the search for new organizational forms of training. Science-educational sources of information (periodicals, books, websites), non-governmental forms of intellectual competitions that are poorly studied in modern pedagogy, have a significant potential in this regard [Bida, 2007: 14-17].

These innovative educational projects diversify organizational forms of students’ educational and cognitive activities; they are effective means of improving pedagogical practice and enriching pedagogical science, an important condition for the formation and development of the scientific worldview of the students. Each project is an independent tool of influencing the educational environment and can be implemented independently. However, coordination of educational activities within the framework of projects provides more effective integrated action. The core among these projects is “KOLOSOK” competition.

Current state

The dynamics of growth in the number of “KOLOSOK” competition participants in Ukraine is demonstrated in Fig. 2. The decline of activity in 2014 was associated with the annexation of Crimea and occupation of the part of Donetsk and Lugansk Regions by Russia.

In 2018, over 529 thousand students took part in “KOLOSOK” competition. The number of participants from rural and urban schools correlates quite well with the percentage of students studying in urban and rural schools of the regions of Ukraine. Fig. 3 demonstrates this distribution in 2017/2018 academic year.

The percentage of students in urban colleges is approximately 69.7%, and the number of participants from urban and rural schools is approximately the same. At the same time, the number of schools involved in the competition in cities is smaller (for example, in Lviv Region the ratio of the number of rural schools to urban is approximately 3:1). Therefore, it is clear that students from villages are more motivated to participate in the competition, partly because they have less opportunities to realize their potential than their peers from cities.

Number of participants in the International Interactive Natural Competition "KOLOSOK" in Ukraine

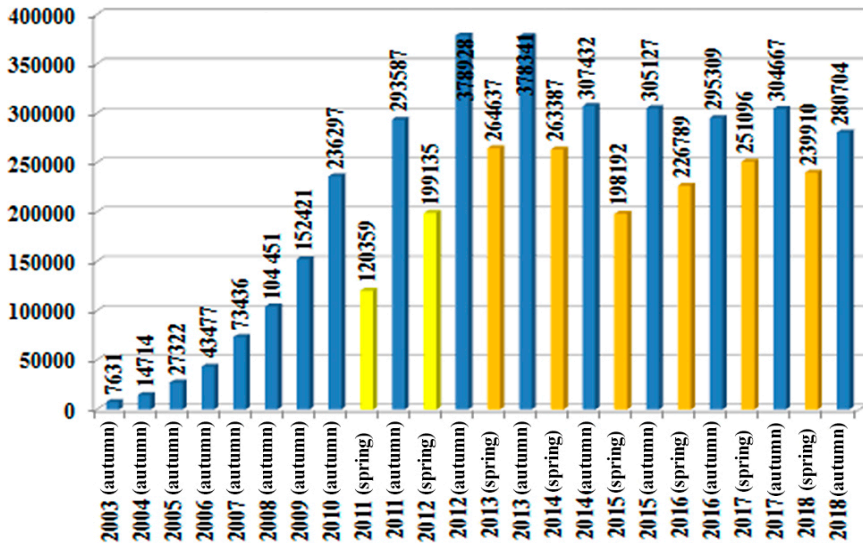


Fig. 2. Number of participants in the International Interactive Natural Competition "KOLOSOK" in Ukraine

Percentage of students in urban and rural schools of the regions of Ukraine in the 2017/2018 academic year

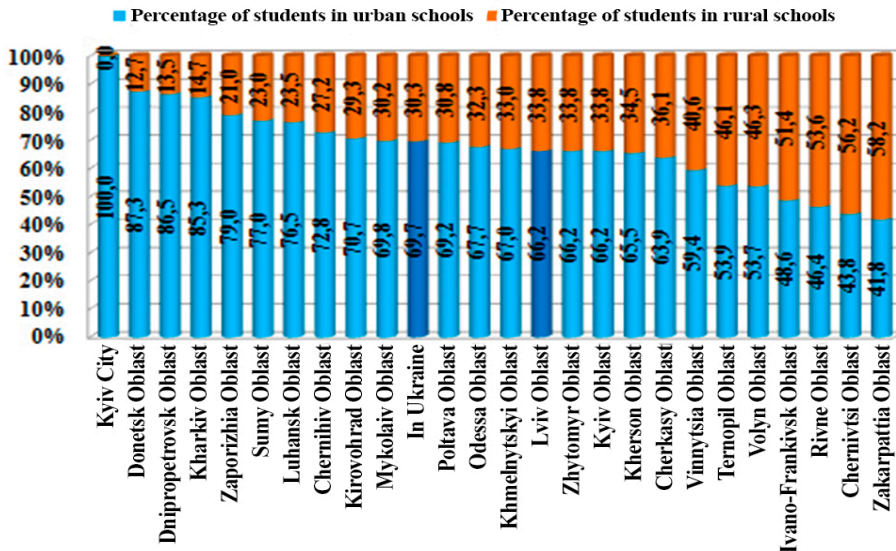


Fig. 3. Percentage of students in urban and rural schools of the regions of Ukraine in the 2017/2018 academic year

The proportion of students in schools of the regions of Ukraine participating in the International Interactive Natural Competition "KOLOSOK -2018 (autumn)" (by classes for the 2017/2018 academic year)

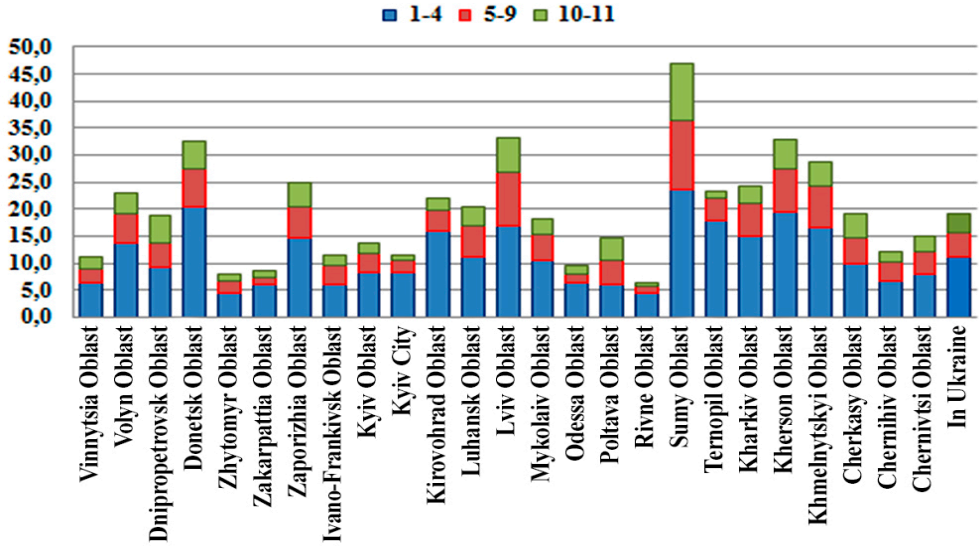


Fig. 4. The proportion of students in schools of the regions of Ukraine participating in the International Interactive Natural Competition "KOLOSOK-2018 (autumn)" (by classes for the 2017/2018 academic year)

The 2-5th grade students represent the most active age group of competition participants (Fig. 4). The organizing committee offers tasks in Ukrainian or Russian (upon choice). Fig. 5 shows the language distribution of the tests.

Number of tests by language parameter

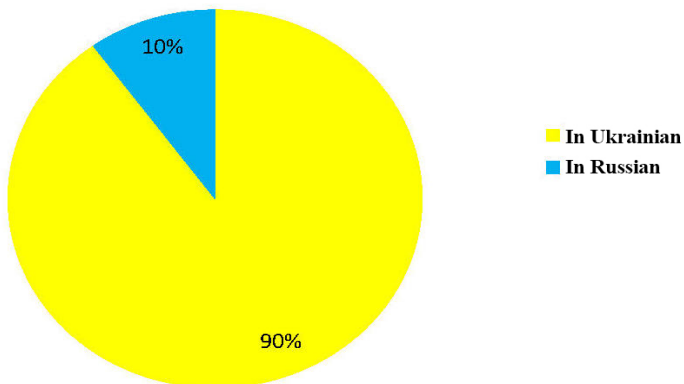


Fig. 5. Number of tests by language parameter

According to contest coordinators and teachers of elementary school and natural subjects, special topics proposed for the contest in 2018 that were interesting for children are: “Movement”, “Forest Life”, “Fantastic Seven and K⁰” (propaedeutics and popularization of physics, chemistry and biology) “The Third Planet”, “Water” Planet, “Life” Planet” (propaedeutics and popularization of astronomy, geography, ecology) [Competition]. As usually, articles devoted to the competition topics are published in “KOLOSOK” magazine (for middle and high grades) and “KOLOSOK” newspaper (for elementary school) to be used for preparation to competition. Thus, the first, preparatory stage of the competition includes individual and group work at home and at school, stimulation of students’ interest and curiosity, advancement of their knowledge and expansion of their horizons, work with various sources of information (magazines, newspapers, news feed on www.facebook.com/Konkurs.Kolosok). In 2014, the Organizing Committee of the competition initiated the All-Ukrainian social project, “Free access to popular science sources of information”, according to which all materials to prepare for the competition are available on the website www.kolosok.org.ua.

Since 2019, the magazine uses augmented reality technologies. With QR codes a reader can watch an educational video or a training film, and check his/her understanding of the article through testing.

The preparatory stage of the competition is the most important, because it is well-known that periodicals are among the most effective ways of attracting children to consistent and regular reading, establishing stable communication skills of working with literature, promotion of special knowledge, development of aesthetic sphere, and comprehensive development of personality. In recent years, the magazine’s subscription has fallen by 20%, which is one of the indirect evidences of a decline in interest to reading print media. There is a dangerous tendency in Ukraine: reading loses the status of a national cultural tradition; the level of population literacy, especially in adolescents and youth, is declining, and interest in reading and studying is declining too. We note that interest in reading, in particular popular science publications, not only decreased, but the structure of reading has changed. Children lose the ability to read large, complex texts that require analysis; they prefer short posts with vivid illustrations. In our opinion, there is a need to create a government program of events to support and promote children’s reading in Ukraine.

The second stage of the competition is intellectual competition. Each participant performs test tasks independently. The team of authors suggests that by solving tasks, a student will rely on knowledge from at least three basic interrelated disciplines. The main goal of this approach is to expand knowledge and enrich student’s perception, to assist in comprehensive understanding of the given phenomena, reveal general laws and ideas applied in various sciences, and combine them into an aggregate. At the same time, these tasks can be used during integrated lessons of school educational process that is especially relevant today for teachers of elementary school and natural subjects, mastering the integrated course “Natural Sciences”.

The test form has been chosen for a reason. Compared to other tools of

pedagogical assessment, it gives an opportunity to use computer technologies to verify the correctness of task fulfillment and process obtained results; to create equal conditions for all test participants; to standardize and automate the verification of results; to engage a large number of students. The main drawback of the test tasks is the ability to guess the answers and ineffective assessment of the degree of systematic and profound knowledge, methods of activity, creativity, rationality of actions and ability to act independently. This can be adjusted at the next stage of the competition, practiced by experienced teachers.

Following the competition, educators not only analyze difficult tasks in the classrooms, but also organize interdisciplinary design and research activities based on some tasks, including those that go beyond the school curriculum, form STEM-abilities and can be integrating factors, overcoming traditional subject disunity of school education.

Educational web resource for teachers of elementary school and natural subjects, “KOLOSOK”, is available on the website www.kolosok.org.ua. There you can find an archive of newspapers and magazines, active catalogue of published materials presented in accordance with educational topics, an open game contest “KOLOSOK-online” for students, tests of “Teacher of the Year” competition for teachers of natural sciences and high school students wishing to prepare to the external independent testing (EIT), and also for elementary school teachers planning to get certified.

Perspectives

The formation of a new civil society in Ukraine and reforming of school necessitate the application of new approaches in education; in particular, the role of NGOs and parent communities in the development of school is increasing. A school determines its own educational line, may use non-standard own curricula, a teacher has academic freedom, parents decide independently in what activities their children could take part according to their natural abilities. The wider the range of possible challenges for intellectual and emotional capabilities of a child, the more varied is the range of contests, competitions and Olympiads. That is why the role of non-state intellectual competition for school students is increasing, essential among which are the competitions in natural sciences and mathematics that develop the child’s STEM abilities.

“KOLOSOK” educational project represents a powerful resource for the development of STEM education in Ukraine since it bases on the STEM-subjects (physics, astronomy, chemistry, geography, biology, ecology, fundamentals of health protection), use of computer and information technologies, and work with various sources of information. It is an additional tool for the propedeutics of STEM-disciplines and early diagnosis of “natural giftedness”. Such giftedness is manifested in a child’s interest in the world around, natural curiosity, interest in the origin and purpose of objects and phenomena, and their classification. Apart from that, a child is attentive to natural phenomena, causes, consequences, and learns how to make

questions, and tries to conduct some experiments. According to some scientists [Lysitsa & Gorchak 2013: 101-105], natural giftedness may be the best identified at preschool and primary school age, and in fact, younger students are the most active participants of “KOLOSOK” competition (Fig. 6). The same authors provide recommendations on identifying abilities to scientific work. Without getting into specifics of these measures, we should note that “KOLOSOK” project forms the child’s skills:

- to clearly express own thoughts;
- to read books, scientific literature, ahead of the school curriculum;
- to demonstrate abilities in using abstract concepts and establishing generalizations;
- to read supplementary non-fiction books and magazines after classes;
- to understand causes and essence of events;
- to spend a lot of time on developing projects, designing;
- to discuss scientific events, inventions, often have them on his/her mind.

The number of participants in the International Interactive Natural Competition "KOLOSOK -2018 (autumn)" in the regions of Ukraine (by classes)

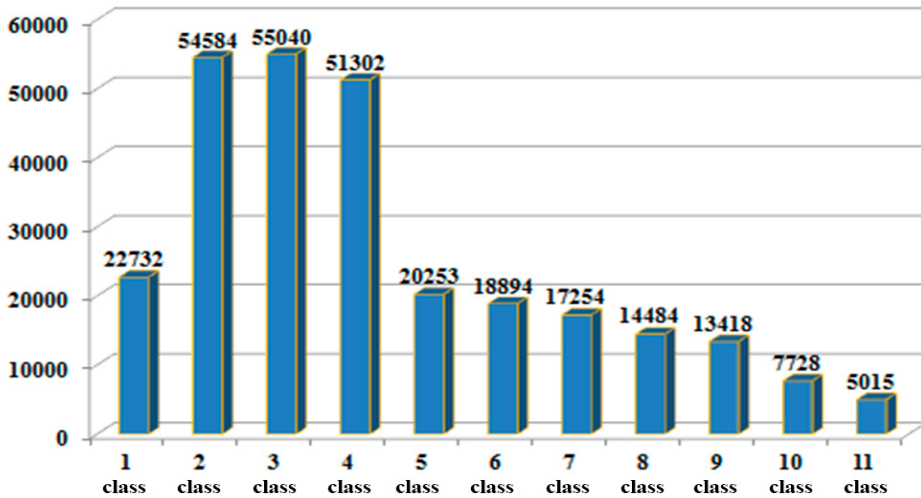


Fig. 6. The number of participants in the International Interactive Natural Competition "KOLOSOK-2018 (autumn) in the regions of Ukraine (by classes)

Only a motivated STEM teacher can inspire a child to learn science and can teach how to work with popular scientific sources of information, engage into observation and experimentation. According to “KOLOSOK” magazine, “Teacher of the Year” contest aims to identify such teachers, popularize and disseminate their experience. In 2019, the following categories – “Research Advisor” and “STEM Teacher” – were introduced into the contest for the first time. This approach continues to be pursued. It should be noted that most of the teachers, which joined the contest program, became active participants of events promoting science, author

unique publications in the magazine and methodological developments, and share with others their experience gained in our project.

Conclusions

In general, non-formal education and intellectual competitions along with related educational projects have a significant potential in terms of science education development in Ukraine. Socio-cultural project “KOLOSOK” and its structural components (competitions for teachers and students, magazine, newspaper, library of popular science literature, web resource) are effective tools for the formation of the educational environment able to solve problems in the field of natural sciences. It aims to enhance child’s interest in cognition, in particular, understanding the laws and phenomena of animate and inanimate nature, science and technology; to recover child’s interest for reading, in particular, popular science literature on natural subjects, and prepare teachers for the forms of work that stimulate reading and self-improvement; to help students in applying all available sources of information, finding the optimum balance between print and electronic means, appreciate both technical innovations and books. More than 500 thousand students annually participate in the natural competition, deepen their knowledge in the field of natural sciences, become interested in STEM-subjects, and develop a taste for reading. Only in such environment it is possible to foster a student that has a mindset of nature enthusiast, scientist and innovator.

At the same time, the proportion of students involved in our projects is relatively small - 14%, comparing to the general student community. Thus, “KOLOSOK” socio-cultural project has even greater potential for the development of STEM abilities in young people, formation of their interest in the natural sciences, and, consequently, establishment of science education in Ukraine. The most promising direction for the development of our project is to attract teachers of preschool educational institutions, pedagogical universities and their students to the popularization of natural knowledge.

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